TRANSLATION (BU-10PCT):

Translated Text of WO 2004/037,579 A1 (PCT/DE2003/003,400) with Amended Claims Incorporated Therein

CONVERTIBLE

The invention concerns a convertible in accordance with the introductory clause of Claim 1 and a convertible in accordance with the introductory clause of Claim 2.

DE 40 04 871 A1 describes a convertible in which, to close the roof, the movement of the tip of the roof into a locked position on a windshield frame has a horizontal motion component. This horizontal motion component is brought about by an additional toggle linkage in the rear section of the roof, which results in considerable extra manufacturing expense. In the lowered state, the toggle linkage requires additional space, which results in a reduction of trunk space. Furthermore, a solution of this type cannot be applied to a roof with rigid roof parts. As always, locking of the tip of the roof on the windshield frame is necessary, and this requires considerable construction space in the area of the tip of the roof or in the area of the crossbar of the windshield frame. This is critical inasmuch as the windshield frame is often very low and flat in modern convertibles with its crossbar positioned above the heads

of the occupants. Therefore, to maintain head clearance and especially to avoid the risk of injury when a person gets in or out of the vehicle and in the event of an accident, any restriction of the space in this area must be avoided.

The invention is based on the problem of creating a convertible that allows optimized indirect or direct mounting of the front roof section on the windshield frame.

The invention solves this problem with a convertible that has the features of Claim 1 and with a convertible that has the features of Claim 2, which can be realized individually or, advantageously, in combination with one another. Advantageous modifications of the invention are specified in Claims 3 to 22.

In accordance with the invention, the design in accordance with Claim 1 provides a simple means of moving the entire roof horizontally into a position in which it is secured on the windshield frame. No mechanical auxiliary constructions are necessary that would have to move individual parts of the roof towards each other, but rather the roof as a whole can be moved a short distance horizontally or at a slight angle to a horizontal plane.

The design in accordance with Claim 2 allows the horizontal displacement of a roof that can otherwise be swiveled as a whole

to open and close it. The roof can thus be displaced a relatively large distance, for example, to reach a more suitable position in the longitudinal direction of the vehicle to allow folding or unfolding of the roof and can then be brought out of this position for closing on the windshield frame. The drive elements for the translational displacement of the entire roof can be assigned to the main bearing and can thus be located below the belt line in a space that is already being used to hold the main bearing and therefore is noncritical with respect to further use.

A combination of Claims 1 and 2 allows movement between the closed position and the intermediate position that is suitable for swiveling even for an otherwise pure swiveling convertible top or a convertible top supported by means of a multijoint linkage.

A displacement distance of the roof of only a few centimeters is mechanically noncritical. An actuator used for this purpose can be designed simply and compactly. As a result of the small displacement distance, there is only a minimal increase in the amount of time required to open or close the roof.

With lock-free securing of the tip of the roof on the

windshield frame, there is no need for any additional parts in the region that is critical for head clearance. Nevertheless, locking can be reliably achieved by means associated with the pivot bearings. In addition, the weight is reduced at the front end of the roof, which represents the area farthest from the center of rotation of the main bearing, so that the force necessary for lifting the front end of the roof is reduced.

In particular, the invention can also be used in a roof with rigid roof parts.

With the advantageous design in accordance with Claim 11, a middle section that encloses the rear window can be lowered in a position separated from the lateral main posts, so that the stowed dimensioned of the lowered roof can be reduced. Even without an expensive rotational mechanism, the rear window can be lowered in the trunk or folding-top compartment at a higher level that the lateral main posts, so that additional storage space is created below the rear window.

At the same time, the additional support, even in a so-called dead-center position, in which the pivot points of the joints lie one above the other in a line, necessarily prevents the front roof part or a front roof part from tilting down or flipping over towards the rear.

In this regard, the additional support is necessarily active only in this phase of the movement and therefore can have large tolerances.

Advantageously, it can also be active in other phases of the roof opening or closing, and in this regard, the parts that are involved in providing support during the movement can change repeatedly during the movement if there is sufficient elasticity of the parts and/or of their connections. This simplifies the requirements in the manufacture of the vehicles of the invention.

The open-air feeling can be improved, even when the roof is closed, if a panel that acts as a sunroof is assigned to the upper roof part. This panel can be opened by moving it over the rear roof part. It is especially useful for the panel also to be transparent.

Other advantages and features of the invention are apparent from specific embodiments of the object of the invention, which are illustrated in the drawings and described below.

-- Figure 1 shows a convertible of the invention in a schematic side view that is broken off below, with the roof closed.

-- Figure 1a shows a view similar to that of Figure 1 with

the actuator for displacing the main bearing additionally drawn and with the sunroof of a front roof part opened.

-- Figure 2 shows a view similar to that of Figure 1 after horizontal displacement of the roof in the direction opposite the direction of travel to initiate the opening of the roof.

-- Figure 2a shows a view similar to that of Figure 2 with the actuator for displacing the main bearing additionally drawn and with the sunroof of a front roof part opened.

-- Figure 3 shows a view similar to that of Figure 2 during the opening movement of the roof.

-- Figure 4 shows a view similar to that of Figure 3 with the roof completely open and the pivot bearing displaced to the front again.

-- Figure 5 shows a perspective rear oblique view of the roof in a position between Figures 2 and 3.

-- Figure 6 shows a detail view of the tip of the roof, corresponding approximately to the detail VI in Figure 2, in proximity to the windshield frame, showing the directions of movement of the tip of the roof.

-- Figure 7 shows a second embodiment in a view similar to that of Figure 1.

-- Figure 8 shows a view similar to that of Figure 7 at the

beginning of the opening of the roof, corresponding approximately to a dead-center position with joints lying on a line.

-- Figure 9 shows a view similar to that of Figure 8 with the roof opening further progressed.

-- Figure 10 shows a view similar to that of Figure 9 with the roof completely open.

-- Figure 11 to Figure 15 show the sequence of movement of the opening of the roof with a schematic and simplified representation of the active multijoint linkage with lines of action drawn between the joints.

-- Figure 11 shows the roof in the closed position.

-- Figure 12 shows the roof as it is starting to open.

-- Figure 13 shows the roof after it has opened further in a dead-center position with joints lying on a line.

-- Figure 14 shows a view similar to that of Figure 7 after the opening of the roof has progressed further.

-- Figure 15 shows the roof in its completely opened position.

Figure 1 shows a schematic representation of the upper region of a two-seat convertible 1 of the invention. A convertible with more seats, say, two rows of seats arranged one

behind the other, can also be constructed in accordance with the invention.

The vehicle 1 comprises a movable roof, which is labeled as a whole by reference number 2 and has a rear roof part 3 with respect to the direction of travel F. The rear roof part 3 has a flexible or, especially, rigid rear window 4, which, for example, can be made of plastic or, advantageously, glass. In the first embodiment, the roof part 3 has a rigid construction and consists, for example, of steel, a light metal, a metallic foam material, or plastic. It is also possible for the rear roof part 3 to be formed essentially only of a rear window 4 that is curved like an arch.

In addition, the roof 2 comprises a front roof part 5, which, in the closed state, is arranged in front of the rear roof part 3 in the direction of travel F of the vehicle. In the illustrated embodiment with a two-seat vehicle 1, this front roof part 5 is formed by a single panel without further transverse division. In the closed state, the front roof part 5 is supported directly on the windshield frame 7 or indirectly via an interposed additional part, say, a sunshade that can be raised, or some other intermediate part. The roof parts 3, 5 can be designed either as rigid parts or as units covered with a

textile material.

In the illustrated embodiment, the front roof part 5 additionally encloses a displaceable panel 6, which can be opened like a sunroof, which will be described in greater detail below, and displaced over the rear roof part 3 (Figure 1a, Figure 2a).

The roof parts 3, 5 can be moved by means of main bearings 8 laterally mounted in the automobile body. They can be swiveled in the direction of arrow S about horizontal axes associated with these main bearings and moved into the automobile body (Figure 4) or out of it (Figure 1). The two roof parts 3, 5 are connected with each other at a transverse joint 9 in such a way that they swivel together about the main bearing 8 and can simultaneously fold towards each other about the separating line 9 to open (Figure 3). Instead of the pure pivot bearing 8, other movable mounts for the roof 2 on the automobile body are also possible, for example, as described in connection with the second embodiment.

To secure the front roof part 5 on the windshield frame 7, pins 10 are assigned to the roof part 3. They are located approximately in the extension plane of the roof part 5 and are directed in travel direction F in the closed state of the roof.

The pins 10 can fit into complementary recesses 11 of the windshield frame 7. The pins 10 and the recesses 11 can be conically shaped to facilitate centering of the closing roof 2. A positive-locking connection between the closed roof 2 and the windshield frame 7 can be achieved by means of pins 10 held in the recesses 11 (Figure 1). A guiding device 12 (Figure 5) can be provided to support the pins 10 as they are being inserted. In this way, the roof is secured against downward movement of the tip of the roof even in its rearwardly displaced position, which provides additional mechanical stabilization during both opening and closing. If, as explained below, a securing mechanism for the displaceable main bearing 8 is provided, an additional securing mechanism is possible but not necessary.

Instead of the pins 10, it is also possible to provide other suitable securing devices.

A drive mechanism 13, say, a hydraulic cylinder, a shaft, an electric motor or the like, is assigned to each of the lateral main bearings 8. Each of the main bearings 8 -- and thus the roof 2 supported on them -- can be moved by this drive mechanism 8 horizontally in the direction of arrow H (transition from Figure 1 to Figure 2) between a front extreme position, in which a front projecting element 14 of the main bearing 8 lies

in a stop 15, and a rear extreme position (Figure 2), in which the roof 2 has been displaced in the direction opposite the direction of travel F to such an extent that the pins 11 have come out of the recesses 11 of the windshield frame 7. In this position, the roof 2 can swivel freely about the bearings 8 in the direction of arrow S without there being any danger of the tip of the roof colliding with the windshield frame 7.

The distance H between the front and rear extreme positions of the drive mechanism 13 is limited by a possibly adjustable rear stop in such a way that in the rear extreme position of the roof 2, the pins are pulled out of the windshield frame 7 just far enough to allow swiveling to occur. Displacement too far to the rear, on the other hand, would unnecessarily delay the opening or closing operation. Therefore, the distance H between the extreme positions is only a few centimeters, for example, between two and eight centimeters. A displacement distance of about 4 centimeters is typical. The horizontal displacement and the swiveling S of the roof 2 can occur entirely one after the other due to the short displacement distance H.

Instead of the completely horizontal displacements shown in the drawings, the bearings 8 and the roof mounted on them can also be displaced in a plane slightly inclined to the

horizontal, for example, in a plane that can follow a rising belt line 16.

Furthermore, in the illustrated embodiment, a cover 17 of the folding-top compartment is assigned to the rear end of the automobile body, for example, in the plane of the belt line 16, and can be swung upward in the direction of arrow 18.

To keep the closed position of the roof in a locked state and to prevent unintentional opening or unauthorized access to the interior, no locks are necessary in the area of the windshield frame 7, as was mentioned earlier. Rather, locks can be assigned, for example, to the projecting elements 14, which can be secured in the stops 15 by these locks.

To allow the roof 2 to be opened from the closed position (Figure 1) to a completely open position (Figure 4), first the cover 17 of the folding-top compartment opens in the direction of arrow 18. Then, after the locks have been unlocked, which can be accomplished by remote control, the projecting elements 14 of the main bearings 8 are released from the stops 15 by the drive mechanisms 13, and the main bearings 8 are displaced in the direction opposite the direction of travel F. At the same time, the front roof part 5 is horizontally disengaged from the windshield frame 7 by pulling the pins 10 out of the recesses 11

in the direction of arrow H (Figure 2, Figure 6).

The roof 2 is then swiveled about the bearings 8 in the direction of arrow S. At the same time, the roof parts 3 and 5 swivel towards each other about the separating line 9 (Figure 3).

In the open final position (Figure 4), the roof parts lie parallel one above the other. The main bearings 8 can be moved forward again to be secured by the projecting elements 14 on the stops 15. In this way, the open position of the roof can also be locked. The forward displacement also makes it possible to provide an additional securing mechanism that consists in the pins 10, which are again pointing in the direction of travel F, being inserted in mating end supports (not shown), which are fixed with respect to the automobile body.

In the open position shown in Figure 4, the cover 17 of the folding-top compartment can also close back over the roof 2 that has been lowered in this way, so that a harmonious side line is achieved.

As an additional option, a sunroof function for the front roof part 5 can be provided. For this purpose, a panel 6 is guided in longitudinal guides of the front roof part 5. In Figures 1a and 2a, the panel 6 is shown in its open position.

The panel 6 can be opened by transferring it from the longitudinal guides of the front roof part 5 to longitudinal guides of the rear roof part 3, and in its open position, it can be held parallel to and above the rear window 4. In the process, mounting supports of the panel 6, which are positioned in the longitudinal guides, arrive in the common horizontal pivot axis of the roof parts 3 and 5, which is associated with the separating line 9 and runs transversely to the vehicle 1. This pivot axis is associated with both the front roof part 5 and the rear roof part 3 and can be reached in each longitudinal guide without misalignment. As a result, the roof 2 can be opened and closed with the sunroof 6 either open or closed. Figures 3 and 4 show the opening of the roof 2 with the sunroof 6 closed.

A program control can be provided to ensure that the roof 2 can be opened or closed only with the sunroof 6 completely open or completely closed. The panel 6 can possibly be transparent as well to provide a good open-air feeling even when the roof is closed.

Alternatively, it would also be possible for the plate member 6 to be held in its closed state only on the upper roof part 5 and in its open state to be transferred completely to the

rear roof part 3.

In the second embodiment (Figure 7 to Figure 15), the rear roof part 3 has two lateral main posts S4 and a middle section S5 located between them. The middle section encloses the rear window S6, or it can be essentially formed by the rear window S6. Both the main posts S4 and the middle section S5 are rigid and therefore can transmit torques. The main posts S4 and a possible frame of the middle section S5 can be made, for example, of steel, a light metal, a metallic foam material, or plastic. It is also possible for the main posts S4 to be transparent. Moreover, the main posts S4 can be supported by frame parts.

Like the main posts S4, the roof part 5, which is arranged in front of the rear roof part 3 in the direction of travel F, can be made of various materials.

With the roof 2 closed (Figure 7), the main posts S4 extend at least between the belt line L (they can also begin farther below in the automobile body 20) and the upper roof part 5, which is arranged towards the front in the direction of travel F and is located above a passenger compartment. The main posts S4 are supported in their lower region by arms S9a relative to the automobile body 20 on pivot joints S9, which are fixed with

respect to the automobile body at least during the swiveling. Their joint axes run horizontally and transversely to the vehicle 1. In their upper region, the main posts S4 are connected with the roof part 5 on pivot joints S10, which also have horizontal joint axes that extend transversely to the vehicle 1. When the roof is being opened, the roof parts 3 and 5 fold towards each other about the axis of the pivot joints S10.

The lower region of the middle section S5 is supported by arms S11a relative to the automobile body 20 on one or more pivot joints S11, which are fixed with respect to the automobile body at least during the swiveling. Their axes run horizontally and transversely to the vehicle 1. In its upper region, the middle section S5 is connected with the upper roof part 5 on at least one pivot joint S12, which likewise has a horizontal bearing axis that extends transversely to the vehicle 1. In the present embodiment, two pivot joints S11, S12 are provided, which are assigned to both sides of the vehicle 1.

The lower pivot joints S11 of the middle section S5 each lie in a plane above the plane of the pivot joints S9 of the lateral main posts S4. The upper pivot joints S12 of the middle section S5 each lie in a plane above the plane of the pivot

joints S10 of the main posts S4. Here too, the pivot bearings S9 and S11, as parts of a main bearing 8, can be fixed with respect to the automobile body during the swiveling but can be displaced horizontally or almost horizontally between a closed roof position and an extreme rearward position suitable for swiveling.

The joints S9, S10, S11, S12 form a multijoint linkage as seen in a side view -- in the illustrated embodiment, one four-bar linkage on each side of the vehicle. If the connecting lines between the joints S9, S10, on the one hand, and S11, S12, on the other hand, are respectively equally long, this results in an articulated parallelogram -- drawn with broken lines in Figures 11 to 15 -- with the vertices S9, S10, S11, S12.

In addition to this multijoint linkage S9, S10, S11, S12, the front roof part 5 is provided with a separate support S25, which, when the roof 2 is closed, is held visually concealed in a slot guide of the roof 2 and can support the roof part 5 with respect to the automobile body 20. It can be sufficient to provide a support S25 of this type on only one side of the vehicle. It is also possible to assign a support S25 to each side of the vehicle for reasons of symmetry. This support S25 is active at least in the so-called dead-center position shown

in Figure 13, in which all of the joints S9, S10, S11, S12 of the multijoint linkage lie on a line. Without the additional support S25, the front roof part 5 could tilt down out of this position in the direction of arrow S26, thereby moving the middle section S5 about the joints S11, S12 in the direction of arrows S27, S28, or the front roof part 5 could be moved upward in the direction of arrow S29, thereby moving the middle section 5 about the joints S11, S12 in the direction of arrows S30, S31. The support S25 has a double support function for the front roof part 5: it supports it both against the downward direction of arrow S26 and against the upward direction of arrow S29. Therefore, in this embodiment, the support S25 is designed as a rigid link. A Bowden cable, for example, could also be used.

Alternatively, it would be possible to provide, say, a cable line with a return to prevent the front roof part 5 from tilting down under its own weight. The support effect against arrow S29 is less important inasmuch as the weight of the roof part 5 already opposes this movement.

The link S25 can possibly be held with some play in its upper joint S32 on the roof part 5 or in its lower joint S33 on the automobile body 20, since, unlike a guide rod for the pivoting movement of the roof 2, it does not have to have a

guiding function but rather only a supporting function in the aforementioned dead-center position. Accordingly, for example, the upper joint S32 for the link S25 on the roof part 5 can be moved in a slotted link. Likewise, elastic play can also be present in the link S25 itself.

In Figure 13, in the dead-center position, a four-bar linkage is formed by the joints S9, S10 of the main posts S4, on the one hand, and the joints S32, S33 of the support S25, on the other hand.

In a low-tolerance installation of the support S25, the support S25 can also serve as part of a multijoint linkage or an articulated parallelogram, at least during certain phases of the further opening or closing movement of the roof. Thus, for example, in Figure 14 as well, a line of action of the multijoint linkage can lie between the joints S9, S10 of the main post S4, and another line of action can lie between the joints S32 and S33 of the support S25. Similarly, it is also possible for the first line of action to lie between the joints S9, S10 of the main post S4 and for another line of action to lie between the joints S11, S12 of the middle section S5.

Therefore, the activity of the support S25 can vary during the movement and is strictly essential only in the dead-center

position (Figure 13), in which the articulated parallelogram that consists of the joints S9, S10, S11, S12 is completely swiveled, and therefore all axes of these joints lie parallel to one another in a common plane. Therefore, during all the rest of the movement and in the terminal position of the roof 2, the support S25 may be nonessential, since the other two joints S32, S33 provide redundancy of the mechanism for the movement of the roof.

Another advantage of this embodiment is apparent from the fact that both with the roof closed (Figure 11) and with the roof completely open (Figure 15), the articulated parallelogram with the axes of the joints S9, S10, S11, S12 as the vertices is opened wide, so that the force required to move the roof from these terminal positions, especially the completely open position, is minimized, and favorable lever arms for the application of force by the drive mechanism S24 are obtained.

The middle section S5 can consist of a support frame and a transparent panel mounted on it, which serves as the rear window S6. This panel can possibly support the guide rails for the sunroof 6. Many other designs are also possible, possibly also with a frame, in the middle of which the rear window is situated, or with projections welded directly onto a rear

window.

As in the first embodiment, the pivot bearings S9, S11 for the parts S4, S5, which pivot bearings S9, S11 are fixed with respect to the automobile body, are mounted as a whole in a main bearing 8, which can be displaced relative to the automobile body 20 horizontally or almost horizontally in the longitudinal direction of the vehicle.

One drive S24 for each side of the vehicle is sufficient for producing a uniform swiveling movement of the roof 2 about the bearings S9 and S11.

To open the roof 2 from the closed position (Figure 7) to a completely open position (Figure 11) -- without the option of the roof 2 that can be moved as a whole -- the arms S9a are first swiveled by the force of the drive S24 towards the rear about the respective bearings S9, which are fixed with respect to the automobile body (Figure 8, Figure 9). In the example shown here, before the operation of opening the roof is started, the sunroof 6 is first opened by guiding the arms in the guideways and further guiding the panel 6 in the guide rails of the rear roof part 3 in such a way that in the completely open position of the sunroof, the bearing journals are coaxial with the pivot axis of the pivot joint S12. In this process, the

bearing journals continue to be held in the guideways, so that they do not have to overcome either a step or a misalignment as the sunroof 6 is slid open. Since the middle section S5 and the roof part 5 swivel towards each other on the joint S12, during this swiveling, the panel 6 can be held motionless parallel to the rear window S6, which is part of the middle section S5, and yet remain with the arms in the guideways of the front roof part 5.

During the swiveling open of the roof parts 3 and 5, the middle section S5 passes through the extension plane of the main posts S4 due to the height shift of the planes of the joints S9 and S10, on the one hand, and S11 and S12, on the other hand. The long sides of the articulated parallelogram, formed by the main posts S4 and the middle section S5, completely fold towards each other, so that at the end, the parallelogram orientation has changed. In this way, the middle section S5 arrives in a lowered position in the automobile body 20 above the main posts S4 (Figure 10, Figure 15). This is very advantageous, because it results in additional storage space under the middle section S5 with the rear window S6.

The invention can be used both in vehicles with manually moved roofs and in vehicles with fully automatically or

semiautomatically moved roofs 2. It is also possible to provide drives 13 only for the horizontal movement H and to carry out the actual folding or unfolding of the roof 2 manually.